#SN-5 Heat & Regulator Safety-TM

Fermilab

August 23, 1983

TO: Division/Section Safety Officers

FROM: Tim Miller *Tim*

SUBJECT: Heat and Regulator Safety

Attached are two memos which were recently prepared by Charlie Bonham. One concerns heat-related safety and the other pressure regulator safety. They are well written and some good points are made which are of general interest to the Laboratory.

TM/jr

Att.

cc: C. Bonham, w/o att.
L. Coulson, w/o att.
J. Grimson, w/att
R. Orr, w/o att.

L. Coulson

Fermilab

July 29, 1983

RECEIVED
AUG 10 1983
SAFETY SECTION

TO: Addressee

FROM: C. E. Bonham Bonham

SUBJECT: Hot Weather Blues - Safety Considerations

A. People Problems

High heat and high humidity place an extra burden on the body. In our last hot spell, one chap checked into medical with a blood pressure of 180/120 and a resting pulse rate of 120 cpm. The possibility of a heart attack or a stroke is obviously increased under this added stress by just the heat alone. When physical effort is added to the situation, the body is further stressed. The most probable adverse reaction is "heat exhaustion" evidenced by weakness, heavy perspiration, nausea, sometimes dizziness - the victim usually looks ill. These persons should be referred to medical and transported if necessary.

I asked the industrial hygiene group to review our warmer areas last week (Friday July 22, 1983) and their measurements include a wet bulb temperature which corresponds to the way the body responds to heat and humidity. Please review the enclosed report. Direct any questions to either me ext. 4438 or Terry Delaney (Industrial Hygiene ext. 3109)

B. Solvent Drum Problems

Charlie Crose informed me that a unopened 55 gallon drum of Freon had "the poochies" on both end heads. It was stored in the cross-gallery highbay and was soaking in heat radiation from the closed hot roll-up door. We called in the Fire Department to cool the drum with water. Meanwhile, the admonitions from the kibitzers were comforting. One guy told me I'd "get blown to hell" (why is it always "hell" and never "heaven") while another chap told me that I'd "get my arm blown off" - not a pleasant alternative either.

What we had, of course, was a vapor pressure problem. The drums will get the "poochies" at approximately 19 psia and will rupture around 26 psia. I was unable to locate a complete vapor pressure/temperature curve for "Balcotron TF (Freon 113) (trichlortriflouroethane) but listed below are some of the key points:

760 mmHg /118°F - 14.7 psia
780 mmHg /122°F - 15.08 psia
1000 mmHg /135°F - 19.33 psia (bulging of heads)
1100 mmHg /140°F - 21.23 psia - no more data on vp/T curve

Heads rupture at around 1345 mmHg which seems to extrapolate to 156°F if the curve is linear. The exterior drum jacket can usually be assumed to be hotter than the contents. If the heads have already bulged. You can assume that the temperature is already at least 135°F. There is only about 30°F more until rupture so cooldown should commence before attempting to relieve the pressure. Eye/face protection should be worn when venting the drum.

The drums have about 5" of airspace at the top so that they will not rupture from hydraulic pressure. Should the drum have slowly vented off some of the pressurized Freon gas from this void, too rapid cooling can cause collapse of the drum from the reduced pressure from within. Drums are not made to withstand external pressure (i.e. atmosphere less internal pressure).

To avoid these problems, you many consider temporarily loosening the small bung plug slightly upon receipt of the drum from stores. This is ok as long as the drum is stored vertically. The recommended practice is to install a drum vent in the 2" bung. These are a stores stock item 1070-2270. Why fool with this safety vent? Lest calculate the force on the 22" diameter drum head at 19.33 psia or 4.52 psig (differential)

(Pascal's Law) Force = Area x Pressure

$F=(380 in^2)(4.52 \text{ lbs } in^2)$

$A=\pi r^2=3.14x11^2=380 \text{ in}^2$

$P=4.52 \text{ lbs}/in^2$

F=1717 lbs. force on drum head caused by vapor pressure of Freon 113 at 135°F. That's a good reason for a relief valve... Acetone and other solvents have their own vapor pressure problems.

C. High Pressure Cylinder Problems

The pressure of a confined gas (constant volume) is directly proportional to its absolute temperature when gas cylinders are heated, such as by a fire or solar radiation. The pressure increases from within. This is why compressed gas cylinders have a rupture disk relief valve built into the cylinder valve body. Cylinders vent on occassions and nearly every summer at the Laboratory. This is why fuel gas and oxidizers (oxygen & chlorine) must be kept separated in gas cylinder racks. We often note oxygen and acetylene stored together on our inspection, the rupture disk on the fuel gases is normally backed with a wood's metal plug which helps some. However these kinds of accidents have happened frequently enough that the practice of storing fuel and oxidizer gases together has been prohibited by code. Be especially careful during this hot weather that gases are appropriately separated. Thank you.

Addressees:

H. Casebolt
J. Hogan
R. Andrews
C. Rode
L. Coulson
T. DeLaney
R. Kramp

Fermilab

ENVIRONMENTAL SAMPLING REPORT

TO: Charles Bonham DATE: 7/25/83

MR RT DV/MR

FROM: Mike Ruhe, Rick Thacker, Dan Villarreal

DATE OF SAMPLING: 7/22/83, between 1:15 - 2:05 p.m.

LOCATION OF SAMPLING: Main Ring Compressor Buildings

OPERATION: Normal Compressor Operation

TOXIC AGENT SAMPLED: Heat Stress

SAMPLING RESULTS: ^{0}F (WBGT)*

A-Ø	93.2^0	C-Ø (north)	99.0^0	E-Ø	99.5^0
B-Ø (east)	85.9^0	C-Ø (south)	94.9^0	F-Ø	103.4^0
B-Ø (west)	93.1^0	D-Ø	96.7^0		

SAMPLING METHOD: Mini WBGT * (Wet Bulb Globe thermometer)

PERMISSIBLE EXPOSURE LEVELS

*TWA: 86.0 ^{0}F (WBGT) Represents conditions under which it is believed that nearly all workers may be repeatedly exposed, day after day, without adverse effect.

STEL: 109.4 ^{0}F (WBGT) The maximal concentration to which employees may be exposed for a period up to 15 minutes continuously without suffering irritation, chronic or irreversible tissue change, or narcosis of sufficient degree to increase accident proneness, impair self-rescue, or materially reduce work efficiency.

EFFECTS OF EXPOSURE:

Heat Fatigue - impaired performance of skilled tasks
Heat Exhaustion - fatigue, nausea, headache, possible fainting
Heat Stroke - failure of body's temperation regulating mechanisms

COMMENTS/RECOMMENDATIONS:

The DOE standard for heat stress was exceeded in all of the compressor buildings on the day of sampling. Under such conditions, it is recommended that no work be done in those buildings. It should also be noted that usage of fans under such extreme conditions, to relieve heat, is ineffective and may actually compound the problem.

*Heavy work load, 25% work, 75% rest, each hour

cc: L. Berry R. Orr I. H. (3)
H. Casebolt D. Villarreal

L. Coulson

Fermilab

August 1, 1983

RECEIVED

AUG 10 1983

SAFETY SECTION

TO: Cy Curtis

FROM: C. E. Bonham

SUBJECT: Pulling a Vacuum on a Regulator

On July 15, 1983, you asked about the relative hazard of using a vacuum/purge technique on the regulator and associated piping. The potential danger was brought forth, but incompletely discussed on p. 34 of the new Fermilab Safety Handbook. Unfortunately, there are occasions where a pump/purge is essential to assure high purity within a system such as your situation in providing beam protons.

The admonitory comment in the Fermilab Safety Handbook about pulling a vacuum on regulators evolved from an accident at CERN that occurred about 5 years ago. Because the accident involved litigation, CERN was not willing to provide any information about it. Supposedly, a vacuum was drawn on a isobutane regulator which was subsequently connected via gas lines to a chamber. The supply was located in a where it leaked portacamp. An American graduate student entering the portacamp on a late shift, caused the isobutane to explode when he turned on the lights. The fault was apparently traced to the defective regulator. Figure 1 illustrates flammability in air of various gases. Notice the rather narrow limit for isobutane ~2%-4%, compared to the rather broad limits for hydrogen ~4%-78%. The CERN incident was a less probable event because of the restricted range of isobutane, whereas hydrogen mixtures have a wide range and require much tighter controls.

I contacted the Matheson Corp. concerning your problem and they immediately responded with enclosed intercompany memorandum which discusses the problem of pulling a vacuum on regulators. Seemingly only full metal regulator diaphrams are good as a genre and that the delivery gauge be at least a go psig model. The supplier of your Victor model VTS-452-B regulator informs me that it has a stainless steel diaphram and a delivery gauge of 60 psi. It should be o.k. However, if you have any doubts about the Victor, I would suggest you switch to one of the recommended Matheson regulators.

With respect to ventilation of the hut (~512 ft.^{3}), the synchronous motored fans have a "Q" of 575 cfm and as I recall, you have a 6-8 fans, so each fan alone gives an air exchange/minute which is more than adequate in reducing any hydrogen concentration below 4%.

I usually tend to worry about power outages especially when the power comes back on...that would be the least desirable time for leaks to be present. However, you have both top and bottom openings in the hut for natural ventilation which will allow any hydrogen released during a power outage to clear the hut via a natural rise rate of 5'/sec.

The supply bottle is 31 ft^3 of H2 which is enough to provide the 4% lower explosive limit for hydrogen in a volume of 775 ft^3 (about 20% larger than the volume of the hut.) However, hydrogen does not tend to disperse uniformly, but collects in the high spots and could form a 4%-78% explosive mixture, say,along the ceiling.

Inspection of the Cockcroft-Walton dome revealed ventilation ducting. A portion is recirculated and a portion is discharged into the small laboratory in the Linac basement next to the elevator. Somewhere in the ducting is an electronic dust precipitator. I doubt that it is intrinsically safe, and for that matter there is some question if it is even operational. I have made arrangements with Plant Maintenance to inspect it. I presently do not feel it represents a significant problem since it is the final step in a series of remote failure probabilities all of which require simultaneity. You will note, however, that I did post the two huts as "no smoking" areas. This is a standard precaution around hydrogen.

CEB/ew
cc: H. Casebolt
C. Vanecek (Gen. Safety File)
L. Coulson
C. Schmidt

Attachments
Matheson Inter-company memo
"Pulling a Vacuum On Matheson Regulators"

Inter-company MEMORANDUM

TO: Sales Distribution

DATE: 9-18-75

FROM: J. Okladek

SUBJECT: PULLING VACUUM ON MATHESON REGULAT(

CC:

A question often asked by a customer is: "If I want to get rid of the Air in the regulator prior to introducing my gas, may I pull a vacuum on this regulator?"

The answer obviously depends on the regulator that he intends to purchase. If that regulator has metal diaphragms and if the delivery pressure gauge can take the vacuum,the answer is yes. Gauges 0 to 100 ps and higher may be subjected to vacuum without damaging the gauge. 0 to 30 psig gauge would be damaged if subjected to a vacuum which would represent about 15 psi in the negative direction.

Model	Vacuum Permitted	Reason
1	no	rubber diaphragm
2	yes	metal diaphragm-1000 psi gauge can take vacuu
3	yes	" " -2000 " " " " "
4	yes	" " -3000 " " " " "
8	no	L.P. diaphragm is rubber
9	no	" " " "
11 to 14	no	diaphragm is ~~rubber~~ Teflon Coated
15	yes	metal diaphragm- 100 psi gauge can take vacuu
16	yes	" " -1000 psi " " " "
19	yes	" " - L.P. gauges are compound
~~25-26~~	no	rubber diaphragm
~~40~~	no	" "
~~48~~	no	" "
~~49~~	yes	rubber diaphragm, but designed for vacuum
70	no	" " - low pressure gauge
71	no	" " - " " "
71S	no	low pressure gauge
3052/3054	no	rubber diaphragm
3062/3063	yes	no diaphragm, high pressure gauges
3075	yes	" " " " "
3102/3104	yes	metal diaphragm, L.P. gauges are compound
3320	no	rubber diaphragm
3330/3340	no	rubber diaphragm - low pressure gauges.
3500	yes	metal diaphragm - L.P. gauges are compound
3800	yes	" " - " " " "

No longer available

JO:mf